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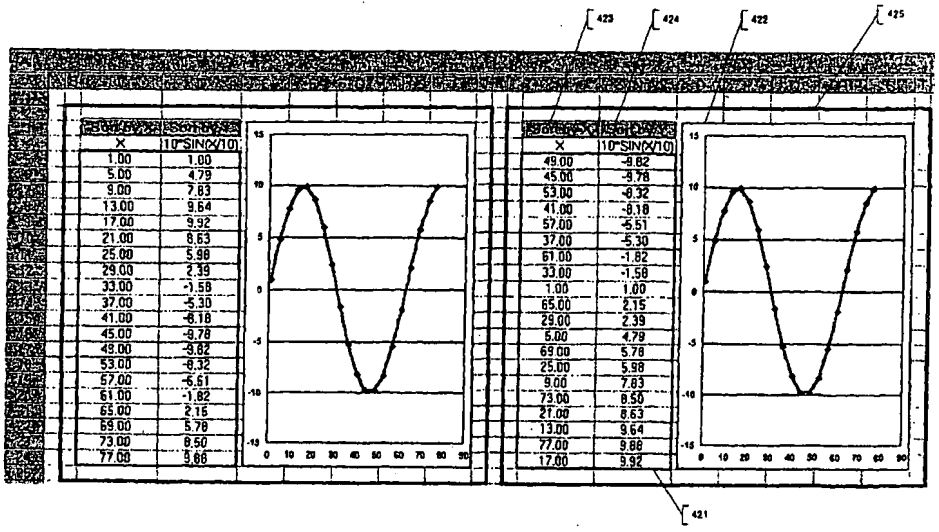

(57) Abstract: The present invention discloses a system and method of copying and pasting a source range of cells (405) onto a destination range of cells (425) in a multi-dimensional spreadsheet comprising a plurality of cells identified by a cell address along each dimension, a range of cells comprising one or a plurality of cells, said source range of cells (405) comprising one or a plurality of working ranges of cells (401), and one or a plurality of fastening ranges of cells in which one or a plurality of graphical objects are represented (402, 403, 404), said one or plurality of graphical objects being associated with said one or plurality of working ranges of cells.

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METHOD AND SYSTEM IN AN ELECTRONIC SPREADSHEET FOR HANDLING GRAPHICAL OBJECTS REFERRING TO WORKING RANGES OF CELLS IN A COPY/CUT AND PASTE OPERATION

Technical field of the invention

The present invention relates to the field of information processing by digital computers, and more particularly to a method and system, in an electronic spreadsheet, for handling graphical objects referring to working ranges of cells in a copy & paste or a cut & paste operation.

Background art

Before computers, numerical analyses, particularly financial ones, were usually prepared on an accountant's columnar pad or spreadsheet, with pencil and calculator in hand. By organising data into columns and rows, spreadsheets afford the rapid assimilation of information by a reader. The task of preparing a spreadsheet on paper, however, is not quite so fast. Instead, the process tends to be very slow, as each entry must be tediously calculated and entered into the spreadsheet. Since all calculations are the responsibility of the preparer, manually prepared spreadsheets are also prone to errors. Hence, preparation of spreadsheets by hand is slow, tedious, and unreliable.

With the advent of microcomputers, a solution was forthcoming in the form of "electronic spreadsheets." Better known simply as "spreadsheets," these software programs provide a computerised replacement for the traditional financial modelling tools: the accountant's columnar pad, pencil, and calculator. In some regards, spreadsheet programs are to those

tools what word processors are to typewriters. Spreadsheets offer dramatic improvements in ease of creating, editing, and using financial models.

A typical spreadsheet program configures the memory of a computer to resemble the column/row or grid format of an accountant's columnar pad, thus providing a visible calculator for a user. Because this "pad" exists dynamically in the computer's memory, however, it differs from paper pads in several important ways. Locations in the electronic spreadsheet, for example, must be communicated to the computer in a format which it can understand. A common scheme for accomplishing this is to assign a number to each row in a spreadsheet, a letter to each column, and another letter to each sheet (or page) of the spreadsheet. To reference a location at column A and row 1 of the second page (i.e., the upper-left hand corner), for example, the user types in "B:A1". In this manner, the spreadsheet defines an addressable storage location or "cell" at each intersection of a row with a column within a given page.

Data entry into an electronic spreadsheet occurs in much the same manner that information would be entered on an accountant's pad. After a screen cursor is positioned at a desired location, the user can enter alphanumeric information. Besides holding text and numeric information, however, spreadsheet cells can store special instructions or "formulas" specifying calculations to be performed on the numbers stored in spreadsheet cells. Such spreadsheet cells can also be defined and named as a range as long as they are arranged as a connex set of cells. A typical example of such a named range simply corresponds to a regular table found in an accountant's pad. In this fashion, range names can serve as variables in an equation, thereby allowing precise mathematical relationships to be defined between cells. The structure and operation of a spreadsheet program, including advanced functions such as functions and macros, are documented in the technical, trade, and patent literature.

Electronic spreadsheets offer many advantages over their paper counterparts. For one, electronic spreadsheets are much larger (i.e., hold more information) than their paper counterparts; electronic spreadsheets having thousands or even millions of cells are not uncommon. Spreadsheet programs also allow users to perform "what-if" scenarios. After a set of computational relationships has been entered into a worksheet, thanks to imbedded formulas for instance, the spread of information can be recalculated using different sets of assumptions, with the results of each recalculation appearing almost instantaneously. Performing this operation manually, with paper and pencil, would require recalculating every relationship in the model with each change made. Thus, electronic spreadsheet systems were invented to solve "what-if' problems, that is, changing an input and seeing what happens to an output.

For this purpose, electronic spreadsheets systems include different means helping the user to both modify one or several inputs and to visualise the resulting effect.

- In the former case, user defined push-buttons with associated software are typical examples of built-in tools available within conventional electronic spreadsheets for manipulating individual cells or ranges of cells.
- In the later case, user defined charts are typical examples of built-in tools available within conventional electronic spreadsheets for seeing the resulting effect of an input change. Indeed a chart makes relationships among numbers easy to see because it turns numbers into shapes (lines, bars, slices of a pie), and the shapes can then be compared to one another.

The ranges of cells, whether they include one or several cells, typically constitute the basic objects handled by and associated with both push-buttons and charts. In the following, such ranges of cells will be referred to as "working ranges". Reversibly, objects like push-buttons and

charts can be "fasten" to the range of cells they overlay on the spreadsheet user computer display. In the following, such ranges will be referred to as the "fastening ranges". When such a fastening range is copied/cut and pasted within a conventional electronic spreadsheet, the objects that are included are also copied/cut and pasted, so that the resulting pasted range contains the same objects as the original fastening range. Therefore the pasted range is also a fastening range. Any object within the pasted fastening range owns the same attributes as the corresponding original object does. This does not present any problem for most of the object attributes (for instance a pie chart is expected to be copied/cut and pasted into a pie chart, not a bar chart), but some limitations exists in conventional electronic spreadsheets for the working range attribute. Indeed with conventional electronic spreadsheets, the working ranges associated with a copied/cut and pasted object are exactly the same as the ones associated with the original object. This is not the normally expected result if the working range is included or equal to the fastening range: in this case, the working range is expected to be treated as a regular relative range, so that the copied/cut and pasted working range occupies within the copied/cut and pasted fastening range the same relative position as the original working range within the original fastening range. As the spreadsheet user wrongly expects that the copied/cut and pasted working range is included in the copied/cut and pasted fastening range, he/she will erroneously interpret the result of a change within the copied/cut and pasted working range. This problem is particularly severe in the case of a cut and paste operation as the cut and pasted objects within a cut and pasted fastening range are associated with working ranges which have been cut and which are thus emptied: in the case of a chart object, the resulting shape (line, bar, slice of a pie) is simply absent. The present invention offers a user-friendly solution to this problem by giving to the electronic spreadsheet user the choice between a conventional copy/cut and paste operation and an enhanced copy/cut and paste

operation where working ranges within fastening ranges are treated as relative ranges.

Summary of the invention

As defined in independent claims, the present invention is directed to a method and system, in an electronic spreadsheet, for handling graphical objects referring to working ranges of cells in a copy & paste or a cut & paste operation.

More particularly the present invention discloses a system and method of copying and pasting a source range of cells onto a destination range of cells in a multi-dimensional spreadsheet comprising a plurality of cells identified by a cell address along each dimension, a range of cells comprising one or a plurality of cells, said source range of cells comprising one or a plurality of working ranges of cells, and one or a plurality of fastening ranges of cells in which one or a plurality of graphical objects are represented, said one or plurality of graphical objects being associated with said one or plurality of working ranges of cells. The method comprises the steps of:

- selecting a source range of cells;
- selecting a destination range of cells;
- copying onto the selected destination range of cells, the selected source range of cells with any graphical object whose fastening range of cells is included in the source range of cells;

for each graphical object whose fastening range of cells is copied onto the destination range of cells and for each working range of cells associated with the graphical object:

- replacing means for identifying the working range of cells within the source range of cells with means for identifying the copied working range of cells within the destination range of cells if said identifying means are not absolute.

Further embodiments of the invention are provided in the appended dependent claims.

Brief description of the drawings

The novel and inventive features believed characteristics of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative detailed embodiment when read in conjunction with the accompanying drawings, wherein :

- Figure **1A** is a schematic view of a computer system in which the present invention may be embodied.

- Figure **1B** is a schematic view a software system including an operating system, an application software, and a user interface for carrying out the present invention.

- Figure **1C** illustrates the basic architecture and functionality of a graphical user interface in which the present invention may be embodied.

- Figure **2A** shows a spreadsheet notebook interface according to the preferred embodiment of the present invention.

- Figure **2B** shows the toolbar component of the notebook interface shown in Figure **2A**.

- Figures **2C** and **2D** show page identifiers for rapidly accessing and manipulating individual pages of the notebook interface shown in Figure **2A**.

- Figures **3A**, and **3B** illustrate a preferred spreadsheet user interface for invoking the "paste" operation, according to the present invention.

- Figures **4A**, **4B**, **4C** and **4D** show a typical spreadsheet structure according to the preferred embodiment of the present invention, and highlight the limitations of prior art.

- Figures **5A** and **5B** are flow charts illustrating a preferred method for the "paste" operation according to the present invention.

- Figure **6** illustrates the structure of the "Working Range of Cells" (WRoC) Table, according to the preferred embodiment of the present invention.

Detailed description of the preferred embodiment

SYSTEM HARDWARE

As shown in FIG. **1A**, the present invention may be embodied on a computer system **100** comprising a central processor **101**, a main memory **102**, an input/output controller **103**, a keyboard **104**, a pointing device **105** (e.g., mouse, track ball, pen device, or the like), a display device **106**, and a mass storage **107** (e.g., hard disk). Additional input/output devices, such as a printing device **108**, may be included in the system **100** as desired. As illustrated, the various components of the system **100** communicate through a system bus **110** or similar architecture. In a preferred embodiment, the computer system **100** includes an IBM-compatible personal computer, which is available from several vendors (including International Business Machine - IBM Corporation of Armonk, N.Y.).

Illustrated in FIG. **1B**, a computer software system **150** is provided for directing the operation of the computer system **100**. Software system **150**, which is stored in system memory **102** and on disk memory **107**, includes a kernel or operating system **151** and a shell or interface **153**. One or more application programs, such as application software **152**, may be "loaded'

(i.e., transferred from storage **107** into memory **102**) for execution by the system **100**. The system **100** receives user commands and data through user interface **153**; these inputs may then be acted upon by the system **100** in accordance with instructions from operating module **151** and/or application module **152**. The interface **153**, which is preferably a graphical user interface (GUI), also serves to display results, whereupon the user may supply additional inputs or terminate the session. In a preferred embodiment, operating system **151** and interface **153** are Microsoft Win95, available from Microsoft Corporation of Redmond, Wash. Application module **152**, on the other hand, includes a spreadsheet notebook of the present invention as described in further detail herein below.

INTERFACE

A. Introduction

The following description will focus on the presently preferred embodiments of the present invention, which are embodied in spreadsheet applications operative in the Microsoft Win95 environment. The present invention, however, is not limited to any particular application or any particular environment. Instead, those skilled in the art will find that the system and methods of the present invention may be advantageously applied to a variety of system and application software, including database management systems, word processors, and the like. Moreover, the present invention may be embodied on a variety of different platforms, including Macintosh, UNIX, NextStep, and the like. Therefore, the description of the exemplary embodiments which follows is for purposes of illustration and not limitation.

Referring now to FIG. **1C**, the system **100** includes a windowing interface or workspace **160**. Window **160** is a rectangular, graphical user interface (GUI) for display on screen **106**; additional windowing elements may be displayed in various sizes and formats (e.g., tiled or cascaded), as desired. At

the top of window **160** is a menu bar **170** with a plurality of user-command choices, each of which may invoke additional submenus and software tools for use with application objects. Window **160** includes a client area **180** for displaying and manipulating screen objects, such as graphic object **181** and text object **182**. In essence, the client area is a workspace or viewport for the user to interact with data objects which reside within the computer system **100**.

Windowing interface **160** includes a screen cursor or pointer **185** for selecting and otherwise invoking screen objects of interest. In response to user movement signals from the pointing device **105**, the cursor **185** floats (i.e., freely moves) across the screen **106** to a desired screen location. During or after cursor movement, the user may generate user-event signals (e.g., mouse button "clicks" and "drags") for selecting and manipulating objects, as is known in the art. For example, Window **160** may be closed, re-sized, or scrolled by "clicking" (selecting) screen components **172**, **174/5**, and **177/8**, respectively.

In a preferred embodiment, screen cursor **185** is controlled with a mouse device. Single-button, double-button, or triple-button mouse devices are available from a variety of vendors, including Apple Computer of Cupertino, Calif., Microsoft Corporation of Redmond, Wash., and Logitech Corporation of Fremont, Calif., respectively. More preferably, screen cursor control device **105** is a two-button mouse device, including both right and left "mouse buttons."

Programming techniques and operations for mouse devices are well documented in the programming and hardware literature; see e.g., *Microsoft Mouse Programmer's Reference,* Microsoft Press, 1989. The general construction and operation of a GUI event-driven system, such as Windows, is also known in the art: see, e.g., Petzold, C., *Programming Windows,* Second Edition, Microsoft Press, 1990. The disclosures of each are hereby incorporated by reference.

B. Preferred interface

Shown in FIG. 2**A**, a spreadsheet notebook interface of the present invention will now be described The spreadsheet notebook or workbook of the present invention includes a notebook workspace **200** for receiving, processing, and presenting information, including alphanumeric as well as graphic information. Notebook workspace **200** includes a menu bar **210**, a toolbar **220**, a current cell indicator **230**, an input line **231**, a status line **240**, and a notebook window **250**. The menu bar **210** displays and invokes, in response to user inputs, a main level of user commands. Menu **210** also invokes additional pull down menus, as is known in windowing applications. Input line **231** accepts user commands and information for the entry and editing of cell contents, which may include data, formulas, macros, and the like. Indicator **230** displays an address for the current cursor (i.e., active cell) position, or the address or name of a selected named range (i.e. active selection). At the status line **240**, system **100** displays information about the current state of the workbook; for example, a "READY" indicator means that the system is ready for the user to select another task to be performed.

The toolbar **220**, shown in further detail in FIG. 2**B**, comprises a row or palette of tools which provide a quick way for the user to choose commonly-used menu commands or properties. In an exemplary embodiment, toolbar **220** includes file manipulation buttons **221**, printing buttons **222**, an undo button **223**, cut, copy, and paste buttons **224**, information pop-up window buttons tool **225**, a named range selection button **226**, a style copy button **227**, a column re-sizing button **228**, and a sum button **229**. The functions of these buttons are suggested by their names. For instance, buttons **224** cut, copy and paste data and objects to and from Windows' clipboard. The same

actions are also available as corresponding commands in the Edit menu (available from menu bar **210**).

The notebook, which provides an interface for entering and displaying information of interest, includes a plurality of spreadsheet pages. Each page may include conventional windowing features and operations, such as moving, re-sizing, and deleting. In a preferred embodiment, the notebook includes 256 spreadsheet pages, all of which are saved as a single disk file on the mass storage **107**. Workspace **200** may display one or more notebooks, each sized and positioned (e.g., tiled, overlapping, and the like) according to user-specified constraints.

Each spreadsheet page of a notebook includes a 2-D spread. Page A from the notebook **200**, for example, includes a grid in row and column format, such as row 3 and column F. At each row/column intersection, a box or cell (e.g., cell **C4**) is provided for entering, processing, and displaying information in a conventional manner. Each cell is addressable, with a selector being provided for indicating a currently active one (i.e., the cell that is currently selected).

As shown in FIGS. **2C-D**, individual notebook pages are identified by page identifiers **260**, preferably located along one edge of a notebook. In a preferred embodiment, each page identifier is in the form of a tab member (e.g., members **261a**, **262a**, **263a**) situated along a top edge of the notebook. Each tab member may include representative indicia, such as textual or graphic labels, including user selected titles representing the contents of a corresponding page. In FIG. **2C**, the tab members **260** are set to their respective default names. For example, the first three tab members (members **261a**, **262a**, **263a**) are respectively set to A, B, and C. Tab members are typically given descriptive names provided by the user, however. As shown in FIG. **2D**, for example, the first three tab members have now been set to "Contents" (tab member **261b**), "Summary" (tab member **262b**), and "Jan" (tab member **263b**). In a

similar manner, the remaining tabs are set to subsequent months of the year. In this manner, the user associates the page identifiers with familiar tabs from an ordinary paper notebook. Thus, the user already knows how to select a page or spread of interest: simply select the tab corresponding to the page (as one would do when selecting a page from a paper notebook).

In addition to aiding in the selection of an appropriate page of information, the user-customizable page identifiers serve aid in the entry of spreadsheet named range addresses. For example, when entering a formula referring to a named range of cells on another page, the user may simply use the descriptive page name in the named range address, thus making it easier for the user to understand the relationship of the cell(s) or information being referenced.

A general description of the features and operation of the spreadsheet notebook interface may be found in Quattro Pro for Windows *(Getting Started, User's Guide and Building Spreadsheet Applications)*, available from Borland International.

RANGE DEPENDENT OBJECTS IN A COPY/CUT AND PASTE OPERATION

A. Introduction

Conventional electronic spreadsheets include built-in means allowing the spreadsheet users to easily apply changes to ranges of cells and to easily represent the resulting effect on other ranges of cells. Typical examples of such means are push-button objects, with their associated macros or scripts, and chart objects. These objects are linked to two different types of ranges of cells: the so-called "***Working Ranges of Cells***" and the so-called "***Fastening Ranges of Cells***".

This is illustrated in the example of FIG **4A** showing a portion of the display device **106** where a range of cells representing

the trigonometric function Y=10*sin(X/10) is represented by a chart. This range of cell **401**, delimited by a solid line, identified by its address C5..D24, and named as "TRIGOTABLE", contains two columns: the left one contains a set of values X_i for the X variable and the right one contains the set of corresponding values $Y_i=10*\sin(X_i/10)$. On the right side of the range of cells **401**, the spreadsheet user has defined a chart **402** showing a plot of the trigonometric function Y=10*SIN(X/10) for the sample values represented by the range of cells **401**. Above the left column of the range of cells **401**, the spreadsheet user has defined a push-button **403** entitled "*Sort by X*" whose effect is to sort the range of cell **401** by the X values. Above the right column of the range of cells **401**, the spreadsheet user has defined a push-button **404** entitled "*Sort by Y*" whose effect is to sort the range of cell **401** by the Y values. This effect is shown in FIG **4B**, where the named range "TRIGOTABLE" **411** has been sorted by the rightmost column, so that the resulting chart **412** shows a different curve than the one shown in the chart **402** of FIG **4A**.

- **Working Ranges of Cells (WRoC)**

  The push-button objects **403** and **404** and the chart object **402** illustrated in the example of FIG **4A** are all associated to the range of cells **401**. Indeed the two push-button objects **403** and **404** allow to sort the range of cells **401**, and the chart object **402** gives a graphical representation of a function Y=10*SIN(X/10) whose sample values constitute the range of cells **401**. For each of these three objects **402**, **403** and **404**, the range of cells **401** will be referred to as a "Working Range of Cells" or WRoC. More generally, any range of cells handled by a graphical object in an electronic spreadsheet will be referred to as a "***Working Range of Cells***" or ***WRoC*** associated to this object. Within an object oriented software engineering environment, this can be formally specified through the definition of a specific object property associated to the object representing a push-button or a chart.

- **Fastening Ranges of Cells (FRoC)**

In conventional electronic spreadsheets, objects like push-buttons or charts can be fasten to a range of cells. When such graphical objects are created, they fasten by default to the range of cells delimited by their top left and bottom right corners. An object fastened in this way can move and change size with the cells behind it. For example they can move and change their size when columns and rows are either inserted or deleted, or when the column widths or the row heights get changed. The range of cells to which such an object is fastened will be referred to as the "***Fastening Range of Cells***" or ***FRoC***.

In the example of FIG **4A**, the push-button object **403** is fasten to the FRoC made of a single cell with address A:C3; the push-button object **404** is fasten to the FRoC made of a single cell with address A:D3; the chart object **402** is fasten to the FRoC with address A:E3..A:I24.

- **How are treated WRoC when FRoC are copied/cut and pasted?**

Let consider a typical case which is illustrated by the FIG **4C**. Here is shown the result of a copy and paste operation where the spreadsheet user has first selected a range of cells **405** with address A:B2..A:J25 (this range of cells **405** is delimited by a double line border), then copied this range of cells **405** to the clipboard, then selected another range of cells **425** with address A:L2..A:T25, and finally performed a paste operation. This results into copying and pasting the content of all the cells from range of cells **405** onto the range of cells **425**, into copying and pasting all the cell display attributes from range of cells **405** onto the range of cells **425**, and into copying and pasting the graphical objects from range of cells **405** onto the range of cells **425**. The output of this operation is that the range of cells **425** contains a range of cells **421** containing the same values as the original range of cells **401**, a pair of push-buttons **423** and **424** and a chart object **422**. These graphical objects **422**, **423** and **424** own the same attributes as the original graphical objects **402**, **403**, and **404**, but

unfortunately they are all associated to the original WRoC **401** instead of being associated to its copied and pasted version, that is the range of cells **421**. In short we are in a situation where a range of cells **405** containing one FRoC and one WRoC associated to the same graphical object, is copied and pasted onto another range of cells **425**. This copied and pasted range of cells **425** contains a copied and pasted version of the original object, with the associated FRoC belonging to the copied and pasted range of cells **425** whereas the associated WRoC still corresponds to the original WRoC. This situation cannot be perceived as normal as for instance any hit on the push-button **423** or **424** will sort the range of cells **401** instead of the range of cell **421**. Similarly the same problem appears with the graph object **422**: any change in the values of the range of cells **421** will not be reflected in the graph object **422**, which instead reflects the values found in the range of cells **401**. The above problem becomes even more severe in the case of a cut and paste operation. This is reflected in the FIG **4D** showing the result of a cut and paste operation applied to the same objects as the ones involved in the copy and paste operation whose effect is shown in FIG **4C**. Within the range of cells **435** created by the cut and paste operation the graph object **432** does not show any curve as its associated WRoC corresponds to the WRoC of the original object which has been cut and which is thus empty. Within the same range of cells **435**, any click on the push-button objects **433** and **434** results in execution errors as the associated macro or script instructions manipulate ranges which have disappeared. Finally any change in the values of the range of cells **431** will not be reflected in the graph object **432**.

The present invention offer a user-friendly solution to these problems by allowing the electronic spreadsheet user to select a new mode of copy/cut and paste operation of a range of cells by which the WRoC associated to the copied/cut and pasted version of a graphical object is equal to the copied/cut and pasted version of the WRoC associated to the original

graphical object, when this graphical object has a FRoC and a WRoC which are included in the copied/cut and pasted range of cells. In the following, the corresponding new Paste method will be referred to as the "***Comprehensive Paste***" method.

B. WRoC Table

The decision to perform a copy/cut and paste operation according to the ***Comprehensive Paste*** method between a source range of cells and a destination range of cells belong to the spreadsheet user. When this operation occurs, a common repository associated to each graphical object like a push-button or a graph, called *the "WRoC Table"*, is used to record the data required by this operation. This WRoC Table is preferably saved on a non volatile memory (typically but not necessary as part of the spreadsheet disk file on the mass storage **107**) and is preferably associated to a method of the graphical object, when object oriented software engineering techniques are used.

Referring now to FIG. **6**, the WRoC Table **600** associated to a given graphical object corresponds to a logical simple structure made of several records **601**, each of them corresponding to a WRoC associated to this graphical object. Each record includes two fields:

- The *"WRoC"* **602** field is used for identifying uniquely the working range of cells within the spreadsheet. For instance, the Source Range can correspond to the conventional address structure Sheet:RowColumn..Sheet:RowColumn associated to every range of cells (For example D:E10..D:G20 with D as Sheet name, E and G as Row name/number, 10 and 20 as Column name/number). This field may include one or several occurrences of the "$" character to identify a relative address, or an absolute address, or the absolute coordinates within a mixed address.

- The *"Reference Type"* **603** field is used for identifying if the WRoC is referenced as a relative address or as an absolute address or even as a mixed address. This field **603** can respectively take the values RELATIVE, or ABSOLUTE, or MIXED, if the number of "$" characters in the field **602** is found equal to zero, or is found equal to the number of address coordinates, or is found less than the number of address coordinates and strictly positive.

The management of this table is itself conventional and strait forward. Any range of cells, once explicitly or implicitly declared as a working range of cells associated to a given graphical object by the electronic spreadsheet user, results in the introduction of a new record **601** within the WRoC Table associated to the same graphical object. The various means used for explicitly or implicitly specifying if a given range of cells is a WRoC associated to a graphical object are implementation dependent and are therefore not considered as part of the present invention.

C. Scenario

In contrast to just-described conventional tools, the present invention provides a more powerful, user-friendly and interactive approach for handling WRoC during a cut/copy and paste operation, in a form of a so-called "Comprehensive Paste" method.

In a preferred embodiment, the present invention is used in two steps :

- **1. The first step** occurs when the spreadsheet user decides, based on some criteria not detailed here, whether a given range of cells have to be cut or copied to memory (the underlying memory space being known as the clipboard).

  - The user first selects the relevant range of cells by using the pointing device **105** or the keyboard **104** and

then invokes the conventional commands called "***Copy***" or "***Cut***" thanks to conventional means available in spreadsheet environment, such as (but not limited to) dedicated push-buttons, keyboard entry short cuts, menu or sub-menu entries.

- At completion of one of these two conventional commands, the selected range of cells, as well as any fasten graphical object it contains, have been copied by conventional internal routines of spreadsheet program into the memory **102** of the computer system.

- **2. The second step** occurs when the spreadsheet user decides, based on his or her own criteria not detailed here, to take advantage of the present invention while the content of the clipboard is pasted onto a given destination range of cells.
  - The spreadsheet user first selects the relevant destination ranges of cells by using conventional means, such as (but not limited to) the pointing device **105** or the keyboard **104**.
  - Then the spreadsheet user invokes an original specific command called "***Comprehensive_Paste***" thanks to conventional means available in spreadsheet environment, such as (but not limited to) dedicated push-buttons, keyboard entry short cuts, menu or sub-menu entries. In a preferred embodiment of the present invention, the ***Comprehensive_Paste*** command is invoked by clicking with the pointing device **105** first on the conventional "Paste Special" menu entry **301** within the conventional "Edit" menu **300** , as shown in FIG **3A**, then on a specific check box **311** "Comprehensive Paste" introduced within the conventional "Paste Special" dialogue box **310**, as shown in FIG **3B** and then on the "OK" push-button **312** available within this same dialog box "Paste Special" **310**.

D. Comprehensive_Paste method

The method for handling WRoC during a paste operation to take advantage of the present invention can be split into two parts, which are summarised in flowchart **500** of FIG **5A** and in flowchart **510** of FIG **5B**. The first part of the method can be seen as the pre-processing of the *"Comprehensive Paste"* command, and the second part of the method can be seen as the processing of the *"Comprehensive Paste"* command.

The first part of the method comprises the following steps :

- At step **501**, the method is in its default state, waiting for an event to initiate the process.
- At step **502**, the *"Comprehensive_Paste"* command is detected, as a result of an user action. This action can be for instance a specific combination of key on the keyboard **104**, or the click of the pointing device **105** on a specific button, or any other similar means not further specified here.
- At step **503**, a Boolean variable named *"Comprehensive_Flag"* is set to the value TRUE.
- At step **504**, an improved version of the conventional Paste command is invoked. The execution of the conventional Paste command involves different conventional sub-processes, one of them taking care of pasting any graphical object whose FRoC is included in the last cut or copied range of cells. This conventional sub-process will be referred to as the *"Graphical_Object_Paste"* sub-process. The improved version of the conventional Paste command differs from the conventional Paste command only by replacing the *"Graphical_Object_Paste"* sub-process by another sub-process referred to as the *"Comprehensive_Graphical_Object_Paste"*. The description of this sub-process is given in the flowchart **510** of FIG **5B**.
- At step **505**, the Boolean variable named *"Comprehensive_Flag"* is set to the value FALSE. Then is control back to the initial step **501** for handling any new command initiated by the electronic spreadsheet user.

The second part of the method corresponds to a modified version of the conventional sub-process

"Graphical_Object_Paste" in charge of pasting any graphical object whose FRoC is found included in the last cut or copied range of cells. This new version is known as the *"Comprehensive_Graphical_Object_Paste"* and comprises the following steps :

- At step **511**, the method is in its default state, waiting for an event to initiate the process.
- At step **512**, the *"Comprehensive_Graphical_Object_Paste"* command is detected, typically as a result of an invocation as part of the step 504 previously described.
- At step **513**, the parameters of the *"Comprehensive_Graphical_Object_Paste"* command are retrieved:
  - *Source_Range* identifying the source range of cells involved in the current copy/cut and paste operation;
  - *Dest_Range* identifying the destination range of cells involved in the current copy/cut and paste operation,
  - *Source_Graphical_Object* identifying the graphical object (whose FRoC is included in *Source_Range*) handled by the process, and
  - *Source_WRoC_Table* identifying the WRoC table associated to the object *Source_Graphical_Object*.
- At step **514**, the conventional process *Graphical_Object_Paste* is followed to create the copied/cut and pasted version of the *Source_Graphical_Object*. The resulting graphical object, referred to as *Dest_Graphical_Object*, has a FRoC which has the same relative address within the *Dest_Range* range of cells as the relative address of the FRoC of *Source_Graphical_Object* within the *Source_Range* range of cells. In other words, the address offset between the FRoC of *Dest_Graphical_Object* and the FRoC of *Source_Graphical_Object* is equal to the address offset between *Dest_Range* and *Source_Range*.
- At step **515**, a test is performed to check if the *Source_WRoC_Table* is empty. If it is the case, then control is given back to the initial step **511**, for handling any new command invocation. Otherwise control is given to the step **516**.

- At step **516**, a WRoC table is created and associated to the graphical object *Dest_Graphical_Object*. This graphical object, referred to as *Dest_WRoC_Table*, has the same size as the *Source_WRoC_Table*, that is contains as many records of structure **601**, as illustrated in FIG **6**.
- At step **517**, the WRoC table *Source_WRoC_Table* is copied onto the WRoC table *Dest_WRoC_Table*.
- At step **518**, the first record **601** of the *Dest_WRoC_Table* is set as the current record of *Dest_WRoC_Table*.
- At step **519**, a test is performed on the current record of *Dest_WRoC_Table* to determine if the WRoC field **602** is included in the *Source_Range* range of cells, and if the Reference Type field **603** is found different from ABSOLUTE. If it is the case, then control is given to step **520**. Otherwise control is given to step **521**.
- At step **520**, the WRoC field **602** of the current record of the *Dest_WRoC_Table* is replaced by its copied/cut and pasted version within the *Dest_Range* range of cells. In other words, the relative offset of the WRoC field **602** within the *Source_Range* range of cells at the beginning of the step **520** is equal to the relative offset of the WRoC field **602** within the *Dest_Range* range of cells at the end of the step **520**.
- At step **521**, a test is performed to determine if the current record **601** of the *Dest_WRoC_Table* is the last record **601** of *Dest_WRoC_Table*. If it is the case, then control is given back to the initial step **511**, for handling any new command invocation. Otherwise control is given to the step **522**.
- At step **522**, the next record **601** of the *Dest_WRoC_Table* following the current record **601** becomes the new current record **601** of the *Dest_WRoC_Table*. Then control is given to the step **519** for continuing treating the records **601** of the *Dest_WRoC_Table*.

ALTERNATE EMBODIMENTS

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be

understood that various changes in form and detail may be made therein without departing from the spirit, and scope of the invention.

The Comprehensive_Paste method and system according to the present invention may be used advantageously in those environments where elements of information are organised as multidimensional tables having more than three dimensions.

The Comprehensive_Paste method and system according to the present invention may be used advantageously in those situations where a given source range of cells is cut/copied and pasted onto multiple destination ranges of cells.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood that various changes in form and detail may be made therein without departing from the spirit, and scope of the invention.

Claims

What is claimed is:

1. A method of copying and pasting a source range of cells (405) onto a destination range of cells (425) in a multi-dimensional spreadsheet comprising a plurality of cells identified by a cell address along each dimension, a range of cells comprising one or a plurality of cells, said source range of cells (405) comprising one or a plurality of working ranges of cells (401), and one or a plurality of fastening ranges of cells in which one or a plurality of graphical objects are represented (402, 403, 404), said one or plurality of graphical objects being associated with said one or plurality of working ranges of cells, the method comprising the steps of:

- performing a conventional cut or copy operation, said operation comprising the steps of:
  - selecting a source range of cells (405);

- performing a comprehensive paste operation, said operation comprising the steps of:
  - selecting a destination range of cells (425);
  - copying onto the selected destination range of cells (425), the selected source range of cells (405) with any graphical object (402, 403, 404) whose fastening range of cells is included in the source range of cells (405);

for each graphical object whose fastening range of cells (422, 423, 424) is copied onto the destination range of cells (425) and for each working range of cells associated with the graphical object:

- replacing means for identifying the working range of cells (401) within the source range of cells (405) with means for identifying the copied working range of cells

(421) within the destination range of cells (425) if said identifying means are not absolute;

if the operation is a cut operation:

- clearing the source range of cells (405) with all graphical objects (402, 403, 404) whose fastening range of cells is included in the source range of cells (405).

2. The method according to the preceding claim wherein said step of comprises the further step of:

- copying the source range of cells (405) onto a buffer with any graphical object (402, 403, 404) whose fastening range of cells is comprised in the source range of cells;

and wherein said step of copying onto the selected destination range of cells (425), the selected source range of cells (405) with any graphical object (402, 403, 404) whose fastening range of cells is included in the source range of cells, comprises the step of:

- copying the content of said buffer onto the selected destination range of cells (425).

3. The method according to any one of the preceding claims wherein a graphical object is a push-botton (403, 404) linked to a piece of code which when activated, processes the associated one or plurality of working cells (401).

4. The method according to any one of the preceding claims wherein a graphical object is a chart (402) for representing on a graphic the associated one or plurality of working cells (401).

5. The method according to any one of the preceding claims wherein a fastening range of cells is defined by default by

the top left and the bottom right corner of the graphical object (402, 403, 404) represented on the spreadsheet.

6. The method according to any one of the preceding claims comprising the preliminary step of:

for each graphical object (402, 403, 404):

- creating a table (600);
- associating said table with the graphical object;

and for each working range of cells (401) associated with said graphical object:

- storing in a table (600) means (602), preferably a name or an address, for identifying the working range of cells (601, 401);
- storing in said table (600) means (603) for determining whether or not the working range of cells (601, 401) is associated with the graphical object through an absolute identifying means.

7. The method according to any one of the preceding claims wherein the step of copying onto the selected destination range of cells (425), the selected source range of cells (405) with any graphical object (402, 403, 404) whose fastening range of cells is included in the source range of cells (405), comprises the further steps of:

for each destination graphical object (422, 423, 424), a destination graphical object being a graphical object copied in the destination range of cells (425):

- creating (516) a destination table and associating said destination table with the destination graphical object;
- copying (517) the content of the table (600) associated with the source graphical object (402, 403, 404) onto the destination table.

8. The method according to any one of the preceding claims wherein the step of replacing means for identifying the working range of cells (401) within the source range of cells (405) with means for identifying the copied working range of cells (421) within the destination range of cells (425) if said identifying means is not absolute, comprises the further step of:

- replacing in the destination table (600) the means for identifying (602) the working range of cells (401) within the source range of cells (405) with means for identifying the copied working range of cells (421) within the destination range of cells (425) if said identifying means is determined has being not absolute (603).

9. The method according to any one of the preceding claims wherein the relative address offset between the working range of cells (401) within the source range of cells (405) and the copied working range of cells (421) within the destination range of cells (425) is equal to the relative offset between source range of cells (405) and the destination range of cells (425).

10. The method according to any one of the preceding claims wherein the step of performing a conventional cut or copy operation comprises the further step of :

- invoking a conventional cut or copy command;

and wherein the step of performing a comprehensive paste operation comprises the further step of :

- invoking a comprehensive paste command.

11. A system comprising means adapted for carrying out the method according to any one of the preceding claims.

12. A computer program comprising instructions adapted for carrying out the method according to claims 1 to 10 when said computer program is executed.

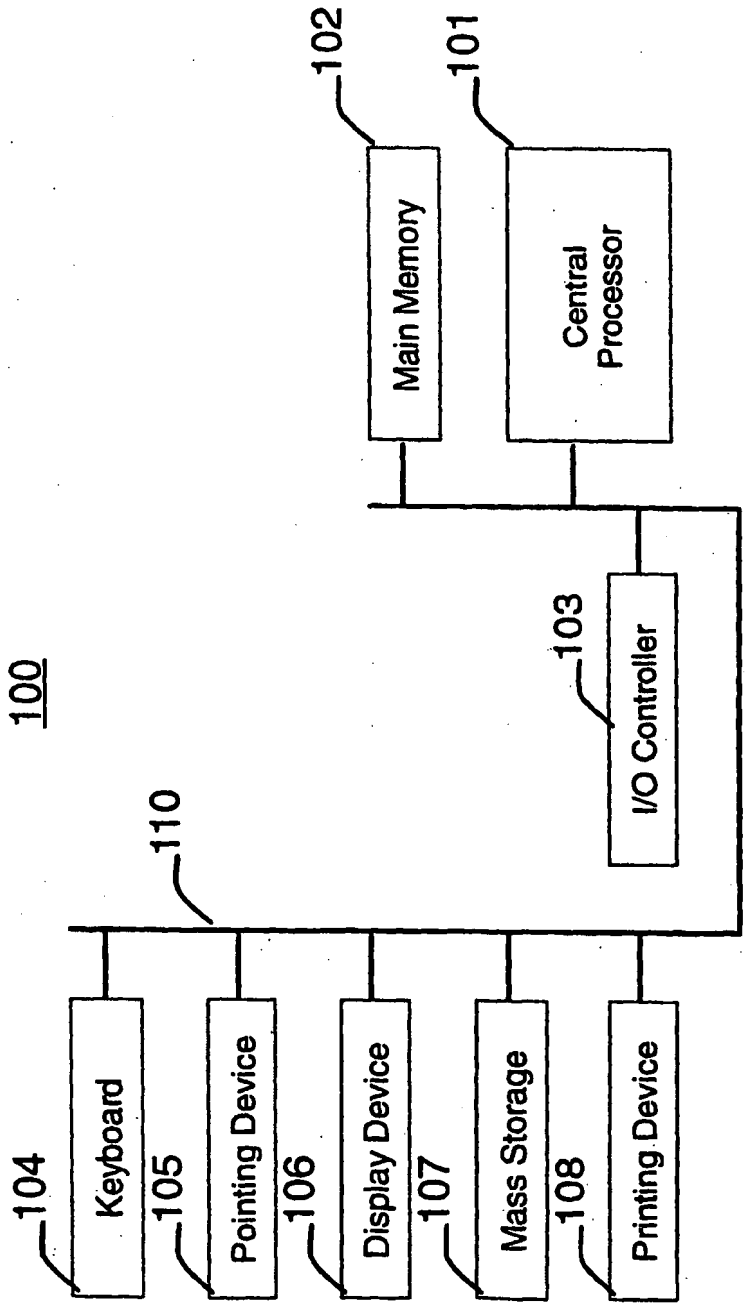

100
110
102
Main Memory
101
Central Processor
103
I/O Controller
104
Keyboard
105
Pointing Device
106
Display Device
107
Mass Storage
108
Printing Device

FIG 1A

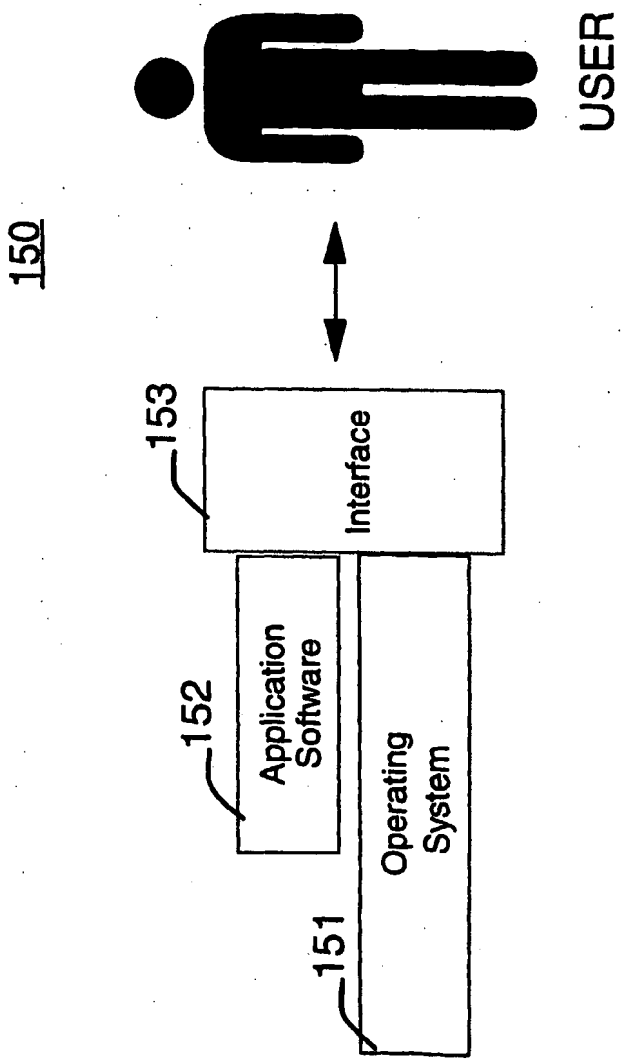

150
USER
153
Interface
152
Application Software
151
Operating System

FIG 1B

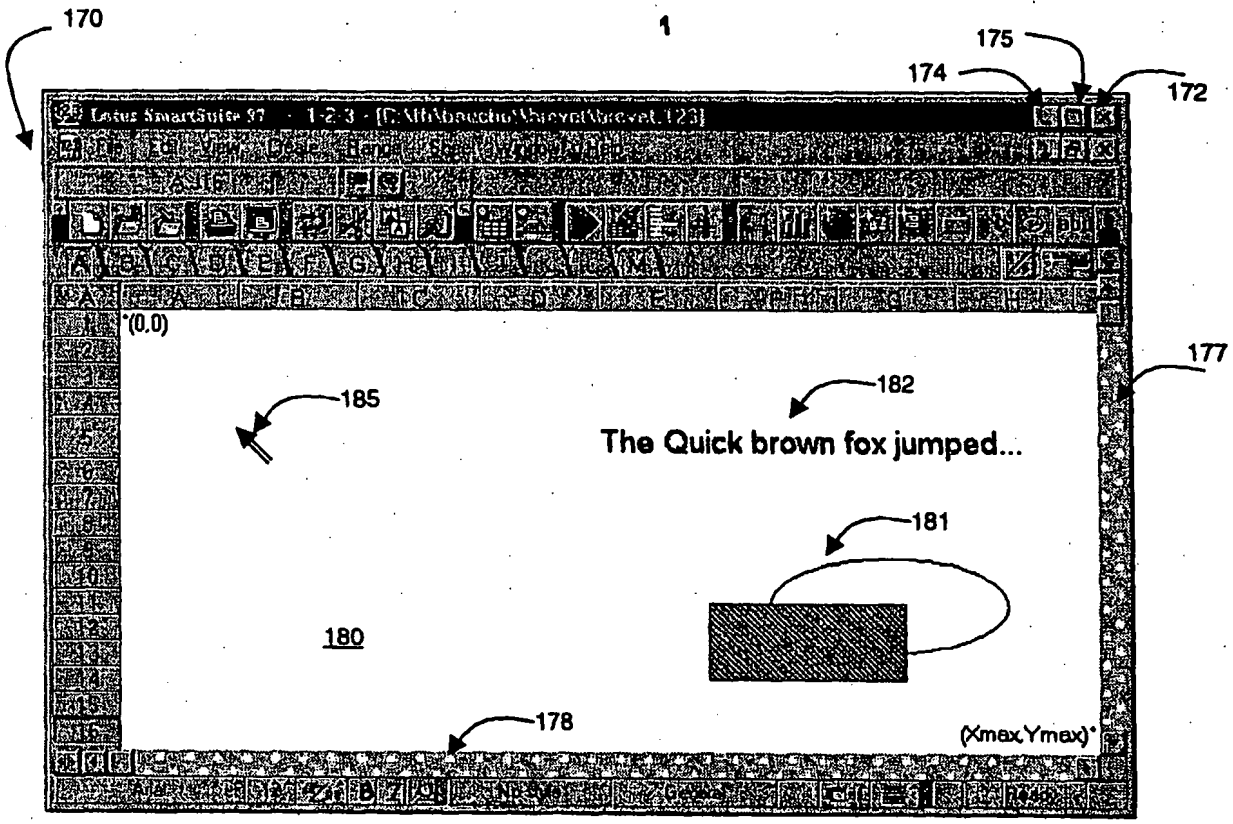

170
1
175
174
172
(0,0)
177
185
182
The Quick brown fox jumped...
181
180
178
(Xmax,Ymax)
160

FIG.1C

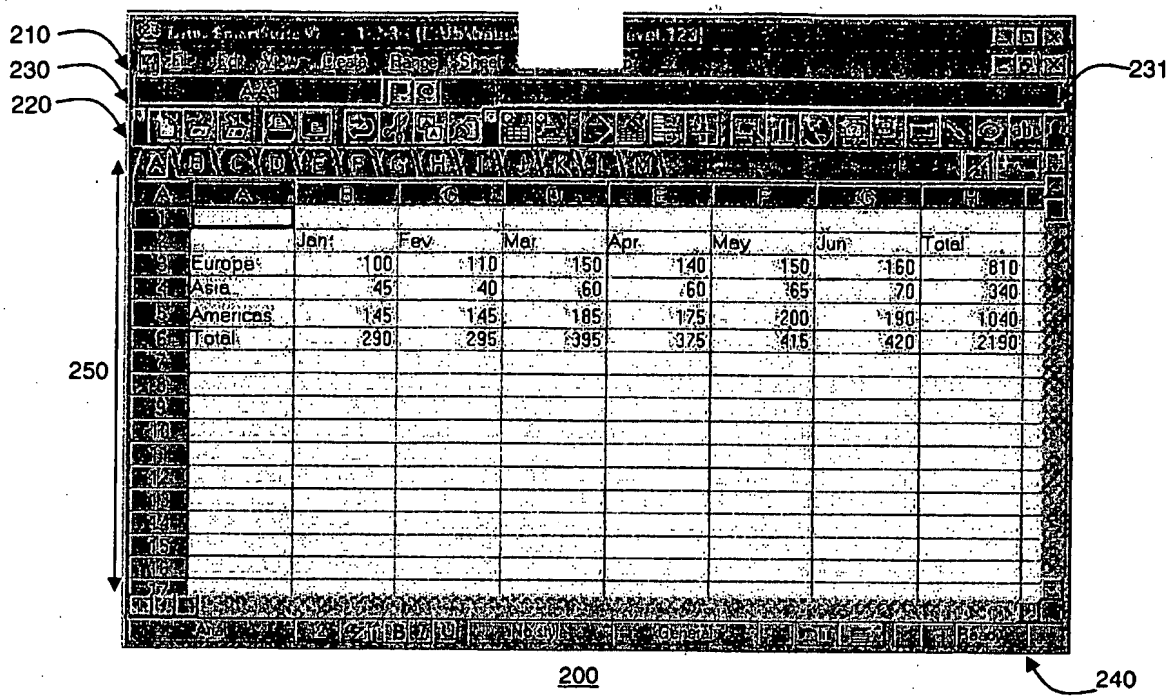

210
230
220
231
250
200
240
Jan
Fev
Mar
Apr
May
Jun
Total
Europe 100 110 150 140 150 160 810
Asia 45 40 60 60 65 70 340
Americas 145 145 185 175 200 190 1040
Total 290 295 395 375 415 420 2190

FIG. 2A

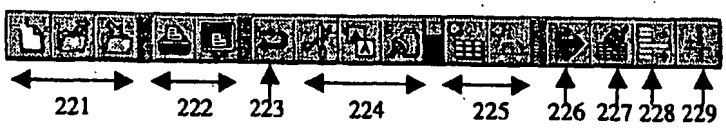


FIG. 2B

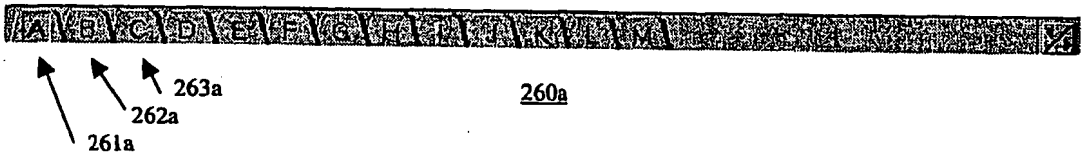


FIG. 2C

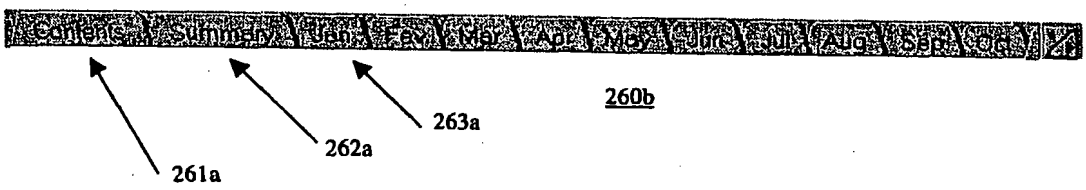


FIG. 2D

Fig. 3A

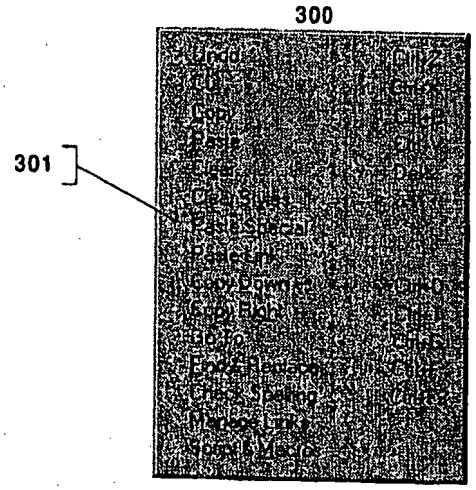
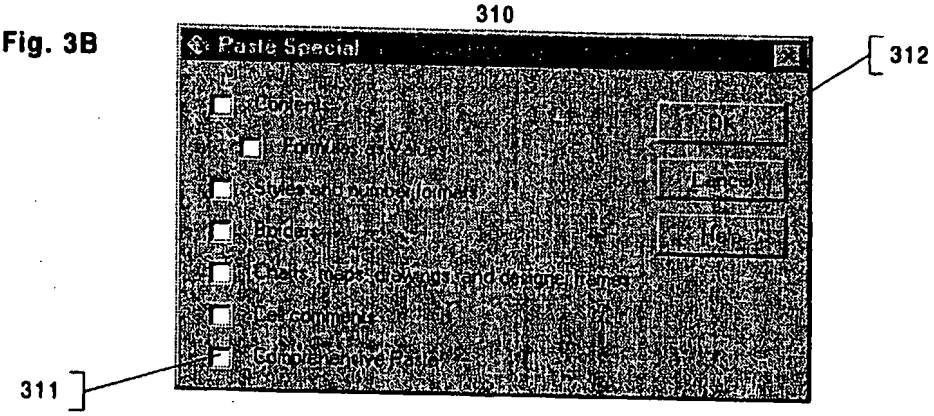


Fig. 3B



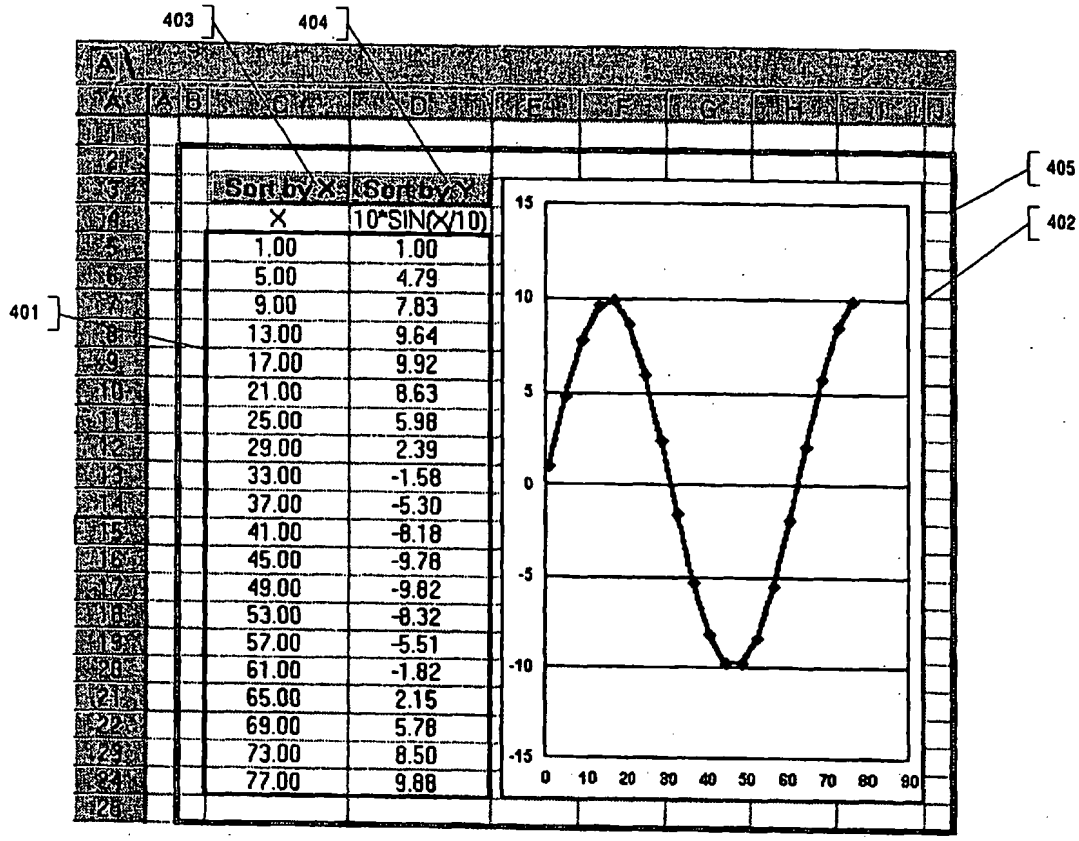

403
404
401
405
402
Sort by X
Sort by Y
X
10*SIN(X/10)
1.00 1.00
5.00 4.79
9.00 7.83
13.00 9.64
17.00 9.92
21.00 8.63
25.00 5.98
29.00 2.39
33.00 -1.58
37.00 -5.30
41.00 -8.18
45.00 -9.78
49.00 -9.82
53.00 -8.32
57.00 -5.51
61.00 -1.82
65.00 2.15
69.00 5.78
73.00 8.50
77.00 9.88
15
10
5
0
-5
-10
-15
0 10 20 30 40 50 60 70 80 90

Fig. 4A

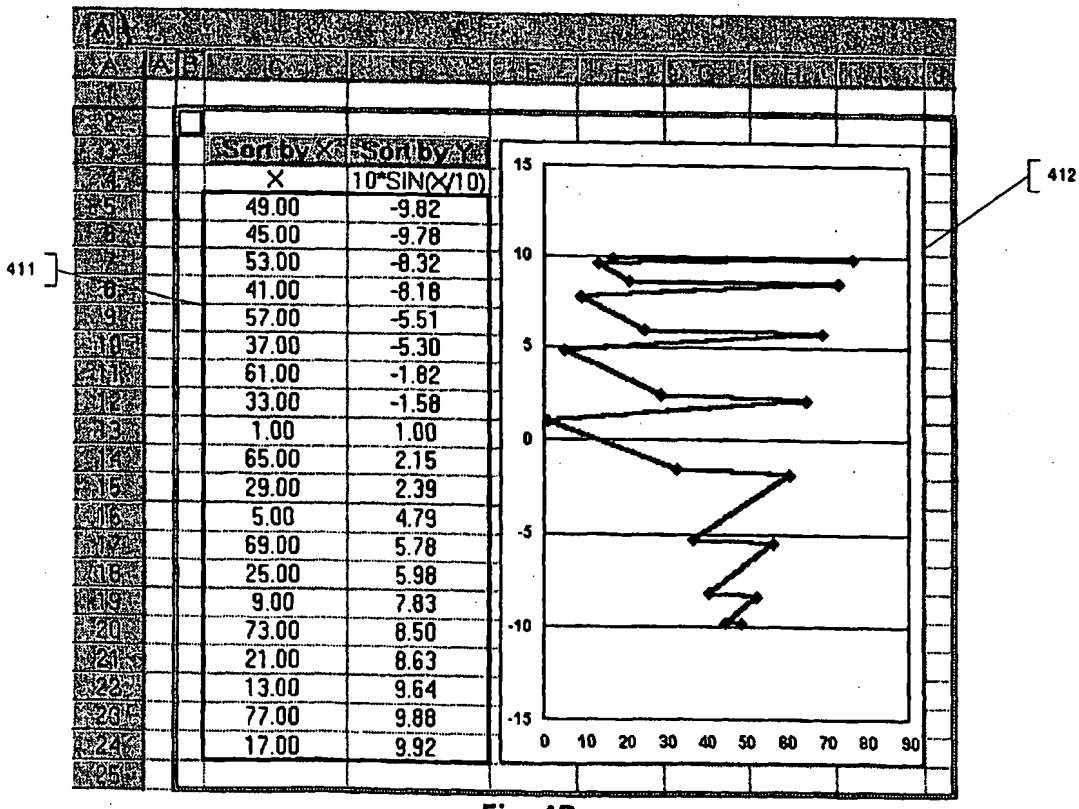

411
412
Sort by X
Sort by Y
X
10*SIN(X/10)
49.00 -9.82
45.00 -9.78
53.00 -8.32
41.00 -8.18
57.00 -5.51
37.00 -5.30
61.00 -1.82
33.00 -1.58
1.00 1.00
65.00 2.15
29.00 2.39
5.00 4.79
69.00 5.78
25.00 5.98
9.00 7.83
73.00 8.50
21.00 8.63
13.00 9.64
77.00 9.88
17.00 9.92
15
10
5
0
-5
-10
-15
0 10 20 30 40 50 60 70 80 90

Fig. 4B

1

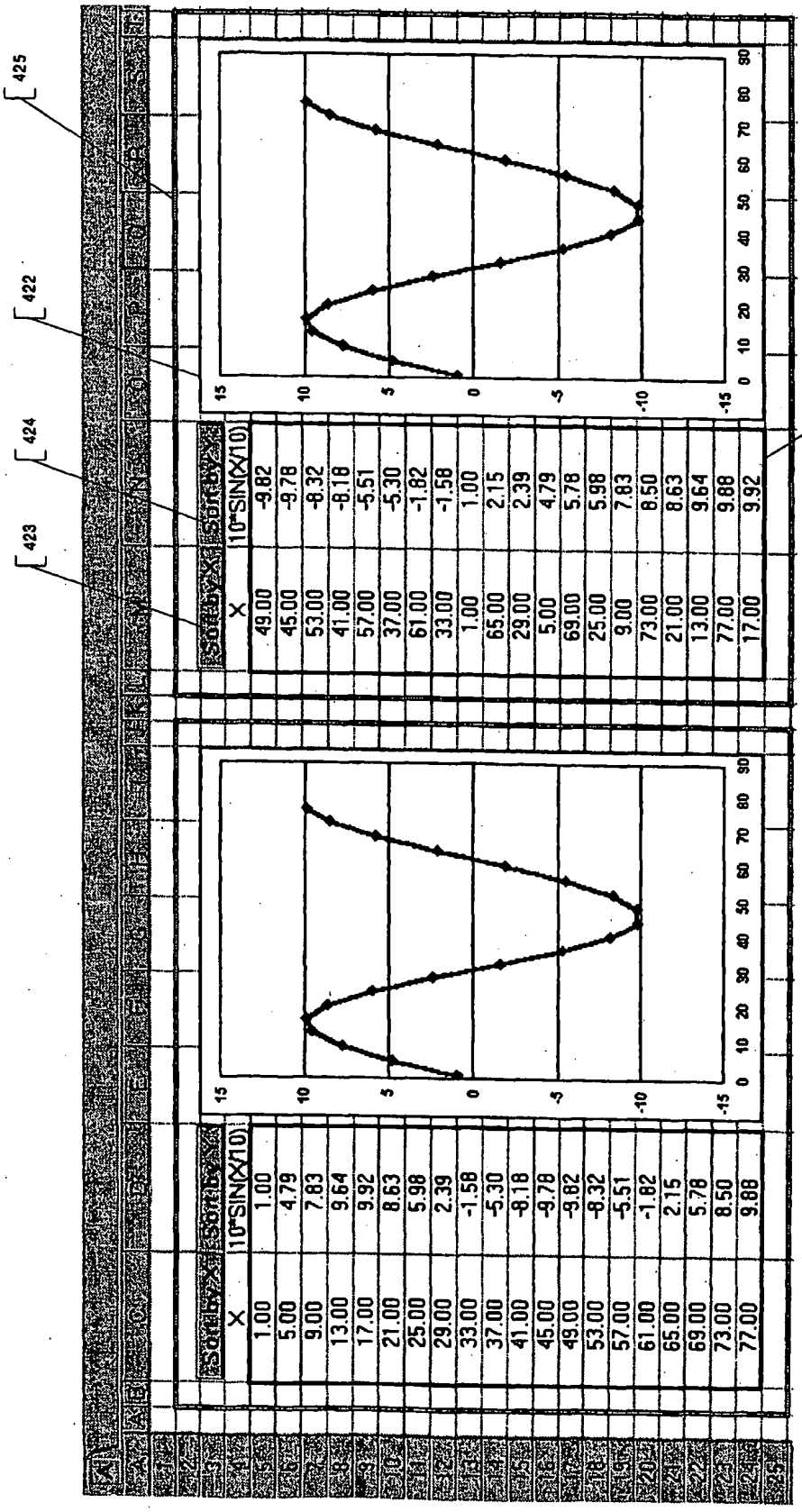

425
422
424
423
421
Sort by X
Sort by X
X
10*SIN(X/10)
1.00 1.00
5.00 4.79
9.00 7.83
13.00 9.64
17.00 9.92
21.00 8.63
25.00 5.98
29.00 2.39
33.00 -1.58
37.00 -5.30
41.00 -8.18
45.00 -9.78
49.00 -9.82
53.00 -8.32
57.00 -5.51
61.00 -1.82
65.00 2.15
69.00 5.78
73.00 8.50
77.00 9.88
Sort by X
Sort by X
X
10*SIN(X/10)
49.00 -9.82
45.00 -9.78
53.00 -8.32
41.00 -8.18
57.00 -5.51
37.00 -5.30
61.00 -1.82
33.00 -1.58
1.00 1.00
65.00 2.15
29.00 2.39
5.00 4.79
69.00 5.78
25.00 5.98
9.00 7.83
73.00 8.50
21.00 8.63
13.00 9.64
77.00 9.88
17.00 9.92

Fig. 4C

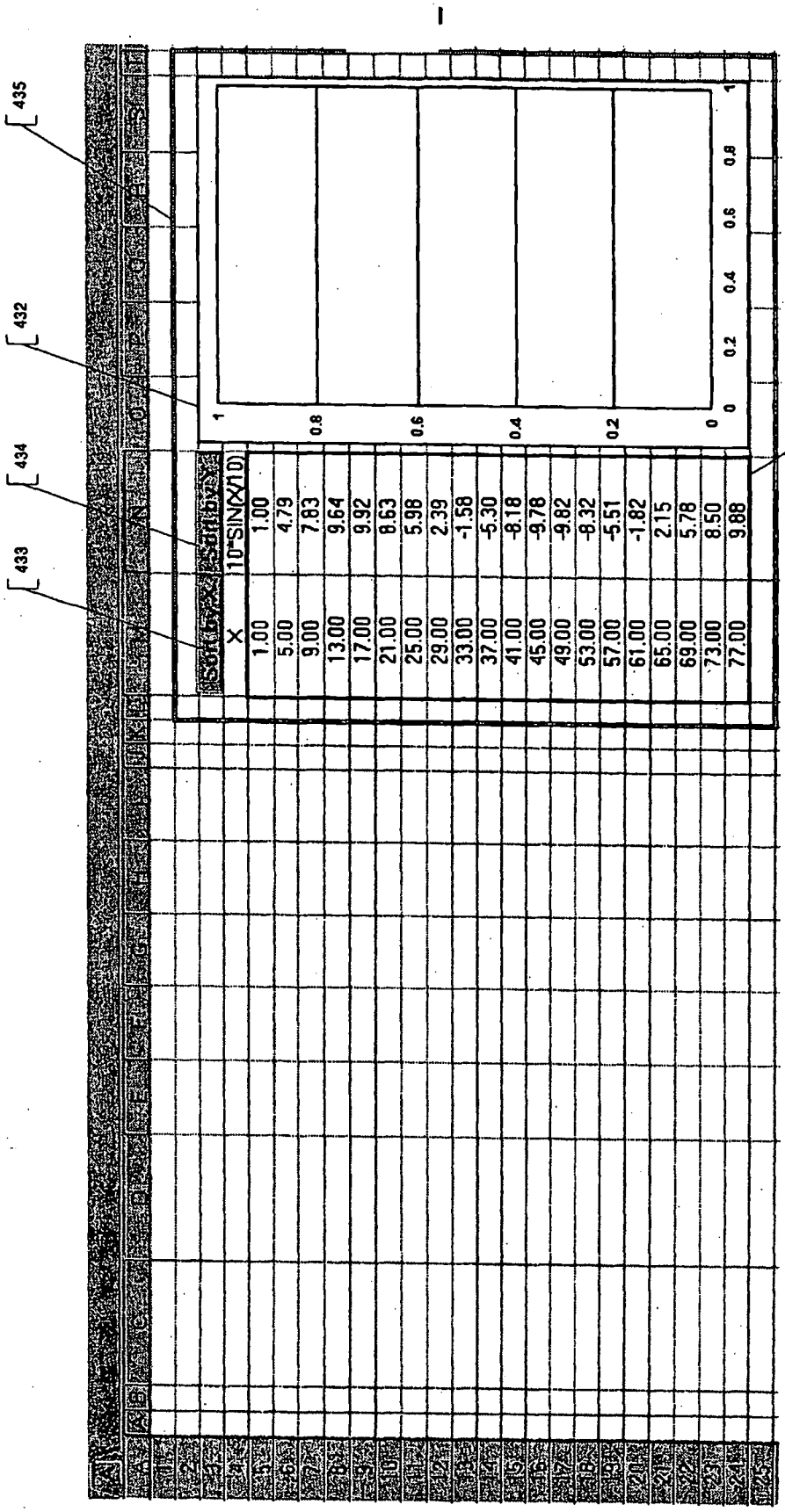

435
432
434
433
431
Sort by X & Sin by X
X
10*SIN(X/10)
1.00 1.00
5.00 4.79
9.00 7.83
13.00 9.64
17.00 9.92
21.00 8.63
25.00 5.98
29.00 2.39
33.00 -1.58
37.00 -5.30
41.00 -8.18
45.00 -9.78
49.00 -9.82
53.00 -8.32
57.00 -5.51
61.00 -1.82
65.00 2.15
69.00 5.78
73.00 8.50
77.00 9.88

Fig. 4D

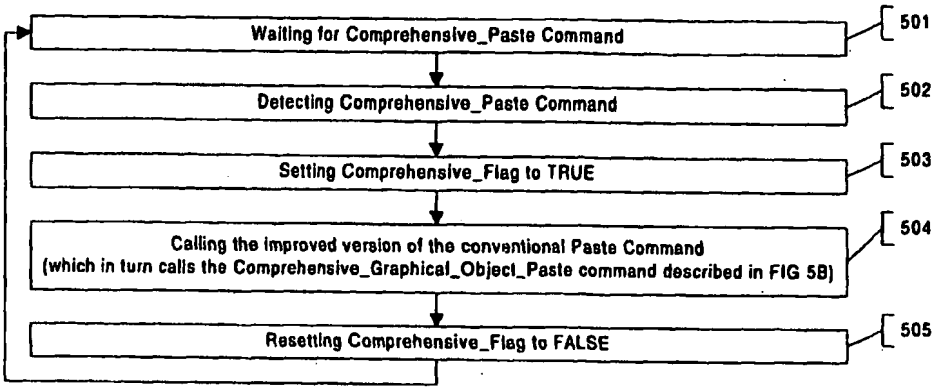

Waiting for Comprehensive_Paste Command
501
Detecting Comprehensive_Paste Command
502
Setting Comprehensive_Flag to TRUE
503
Calling the improved version of the conventional Paste Command
(which in turn calls the Comprehensive_Graphical_Object_Paste command described in FIG 5B)
504
Resetting Comprehensive_Flag to FALSE
505

Fig. 5A

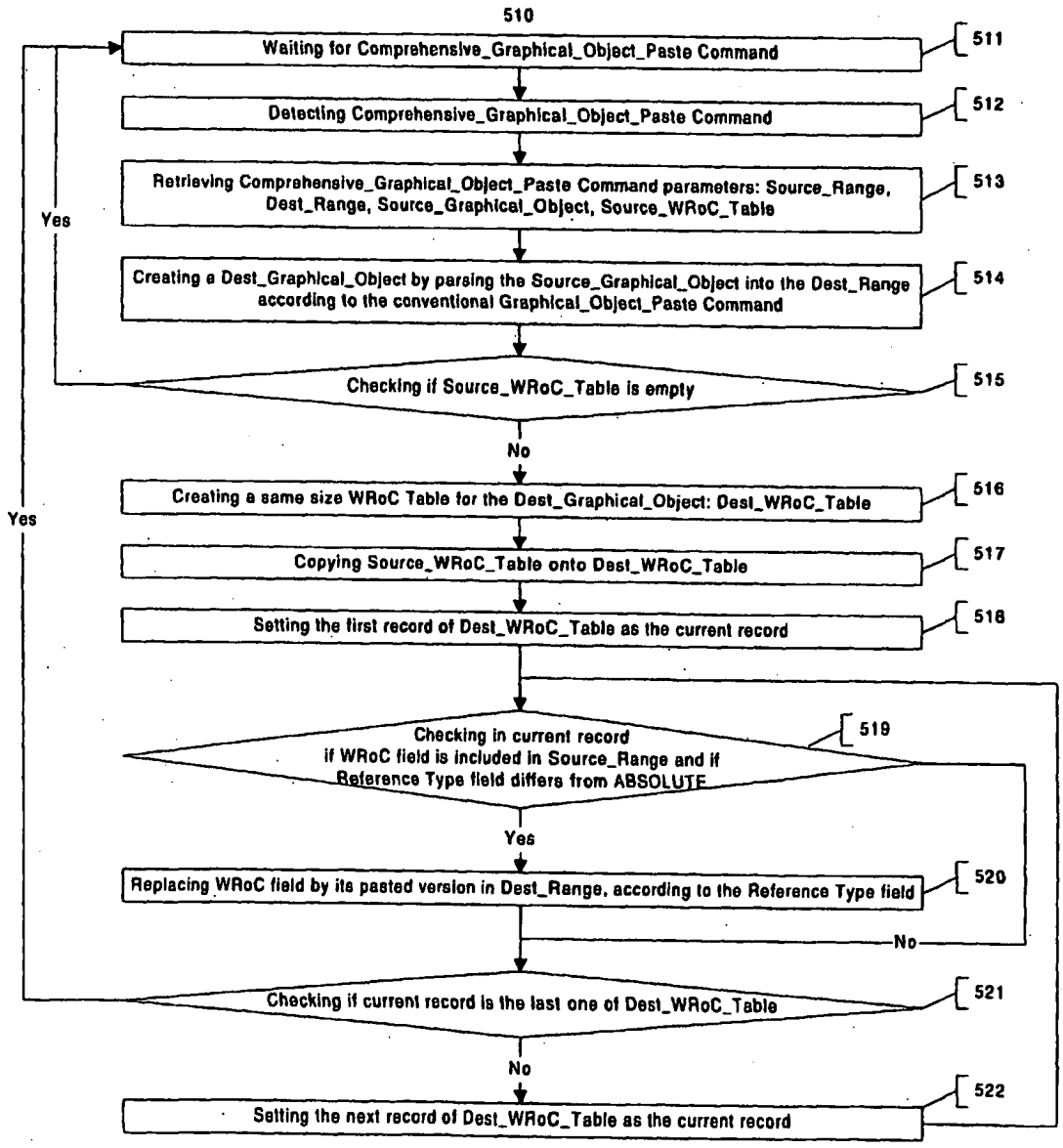

510
Waiting for Comprehensive_Graphical_Object_Paste Command
511
Detecting Comprehensive_Graphical_Object_Paste Command
512
Retrieving Comprehensive_Graphical_Object_Paste Command parameters: Source_Range, Dest_Range, Source_Graphical_Object, Source_WRoC_Table
513
Creating a Dest_Graphical_Object by parsing the Source_Graphical_Object into the Dest_Range according to the conventional Graphical_Object_Paste Command
514
Yes
Checking if Source_WRoC_Table is empty
515
No
Creating a same size WRoC Table for the Dest_Graphical_Object: Dest_WRoC_Table
516
Yes
Copying Source_WRoC_Table onto Dest_WRoC_Table
517
Setting the first record of Dest_WRoC_Table as the current record
518
Checking in current record
if WRoC field is included in Source_Range and if
Reference Type field differs from ABSOLUTE
519
Yes
Replacing WRoC field by its pasted version in Dest_Range, according to the Reference Type field
520
No
Checking if current record is the last one of Dest_WRoC_Table
521
No
Setting the next record of Dest_WRoC_Table as the current record
522

Fig. 5B

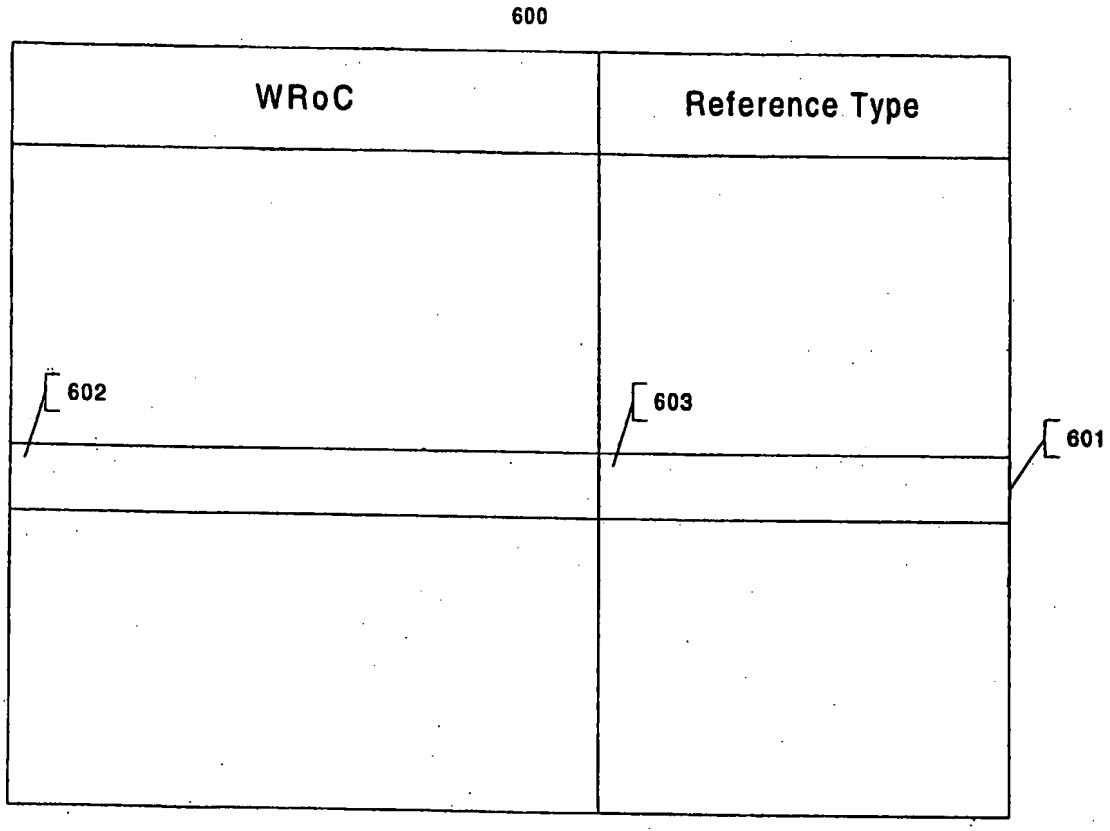


Fig. 6